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SUPERNOVA NANOPARTICLES ARE THE CARRIERS OF ^{54}Cr ANOMALIES IN PLANETARY MATERIALS

N. Dauphas[1,2], L. Remusat[2,3], J. H. Chen[4], M. Roskosz[5], D. A. Papanastassiou[4,2], J. Stodolna[5], Y. Guan[2], C. Ma[2] and J. M. Eiler[2]. [1]Origins Laboratory, Department of the Geophysical Sciences and Enrico Fermi Institute, The University of Chicago. E-mail: dauphas@uchicago.edu. [2]Division of Geological and Planetary Sciences, Caltech. [3]Laboratoire de Minéralogie et Cosmochimie du Muséum, Muséum National d'Histoire Naturelle [4]Jet Propulsion Laboratory. [5]Unité Materiaux et Transformations, Université de Lille 1, France.

Acid leachates and residues of primitive meteorites have revealed large variations in ^{54}Cr relative to terrestrial composition [1–9]. Despite two decades of extensive search, the nature of the carrier of ^{54}Cr excesses is still uncertain. Ion probes offer the opportunity to address directly this question by measuring $^{54}Cr/^{52}Cr$ ratios in individual grains [10–13].

We have measured the Cr isotopic composition of physical and chemical separates from the primitive carbonaceous chondrites Orgueil and Murchison. The colloidal fraction of Orgueil (median grain size of approx. 30 nm) shows the largest ^{54}Cr-excess ever measured in a bulk meteorite residue ($\varepsilon^{54}Cr = 170$). This indicates that the carrier of ^{54}Cr-anomalies was efficiently concentrated by our procedure and that it must be very fine grained (< 100 nm) [also see 3, 4]. In situ Cr isotopic analyses by NanoSIMS of the < 200 nm nominal size fraction of Orgueil (median grain size 184 nm) revealed the presence of ^{54}Cr-rich nanoparticles ($^{54}Cr/^{52}Cr > 3.6 \times$ solar). Heterogeneous distribution of these nanoparticles in the inner solar system is compatible with the variations in ^{54}Cr abundance measured in bulk meteorites and terrestrial planets. Because of their small size, no direct mineralogical characterization of the ^{54}Cr-rich grains could be performed. However, study by transmission electron microscopy shows that ^{54}Cr-rich grains are found in a fraction where the sole chromium-bearing grains are oxides, mostly nanospinels.

At the present time, we cannot tell which of type Ia and II supernovae produced the grains identified here, though the oxide mineralogy would favor condensation from a type II. This question can be addressed in the future by measuring the isotopic abundance of other neutron-rich isotopes, in particular ^{48}Ca [14, 15], in the same grains. Study of these grains will shed new light on the nucleosynthesis of iron-group nuclei and the evolution of supernovae.

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A CONSTANT IDP FLUX BASED ON IRIDIUM ANALYSES OF ARCHEAN SEDIMENTS

A. K. Davatzes[1], D. R. Lowe[2] and F. T. Kyte[3]. [1]Department of Earth and Environmental Science, Temple University, Philadelphia, PA 19122 E-mail: alix@temple.edu. [2]Stanford University, Stanford, CA. [3]IGPP, UCLA, Los Angeles, CA, USA.

Introduction: In modern sediments, iridium (Ir) concentrations are inversely correlated to sedimentation rate because of the near constant flux of Ir-bearing interplanetary dust particles (IDPs) to the Earth's surface [1, 2]. In order to calculate the sedimentation rate in ancient rocks using Ir, the IDP flux must be known. Previous studies [3] have reported low Ir levels in late Hadean/early Archean metasedimentary and metavolcanic rocks from Akilia, Greenland. They suggest that IDP mass accretion rates do not scale to the rate of supply, and that increasing abundance results in increasing collisional loss. Schmitz et al. [4] showed that Ordovician-age sedimentary rocks record higher meteorite flux than modern sediments, but that the IDP flux, based on ^{3}He measurements, was comparable to that of today [5] unless there was significant loss of ^{3}He due to alteration. In this study, we systematically analyzed a section of 3.24 Ga core from the base of the Fig Tree Group in the Barberton greenstone belt (BGB) in South Africa for Ir. The lithology is fine carbonaceous chert and black and white banded chert. There is little coarse debris and the sediments lack evidence of current transport and deposition. These characteristics indicate that this is a condensed section formed at very low sedimentation rates.

Methods: A 4.8 m core was logged for lithology, sedimentary structures, and post-depositional features. It was sliced into 5 cm-long segments, from which a portion spanning the full length was powdered and thin sections were made. Ir was measured in each sample by RNAA and major and trace elements by XRF.

Results and Discussion: Ir concentrations in the 96 samples range from 2 to 663 pg g^{-1}, comparable to the range of concentrations found in modern sediments, suggesting that IDP flux in the Archean must have may not been significantly different than the Phanerozoic mass flux. More than 85% of the Ir concentrations are less than 200 pg g^{-1}, and likely reflect IDP accumulation rates, but several samples had Ir > 200 pg g^{-1}, including two spikes > 600 pg g^{-1}. These could represent extraterrestrial "events" such as impacts or increases in IDP flux. Sedimentation rates in various rocks throughout the BGB have been estimated to range from 10 to 1000 m Myr^{-1}, consistent with estimates in this study (averaging 80 m Myr^{-1}) if IDP flux is the same as modern rates. Rates higher than this are unlikely as they would have resulted in suppression of microbial mat formation and extraordinarily thick rock successions even assuming large breaks in time. Such high rates of sedimentation are also unlikely given that the sediments were deposited in a quiescent marine setting. Very high levels of Ir in the underlying S3 impact layer and lower background levels seen here suggest that though large impacts would have introduced significant amounts of Ir to the Earth's surface, the flux from dust is unchanged compared to today.

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